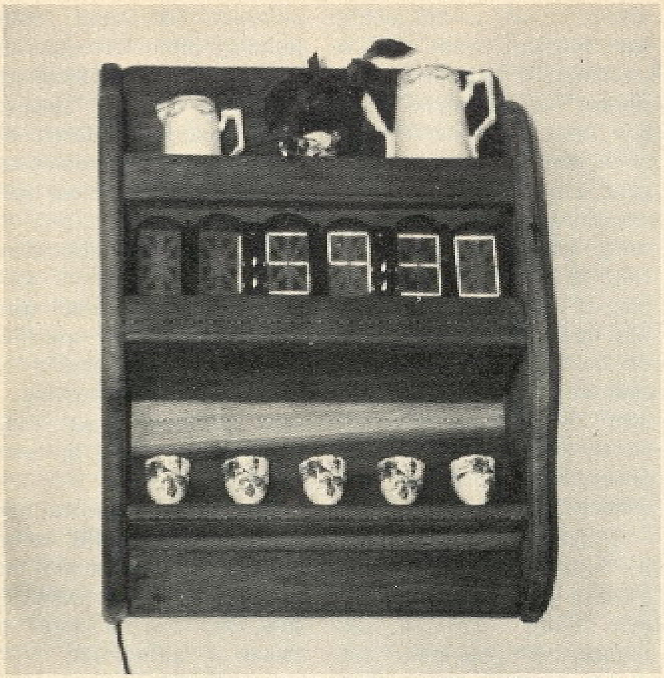
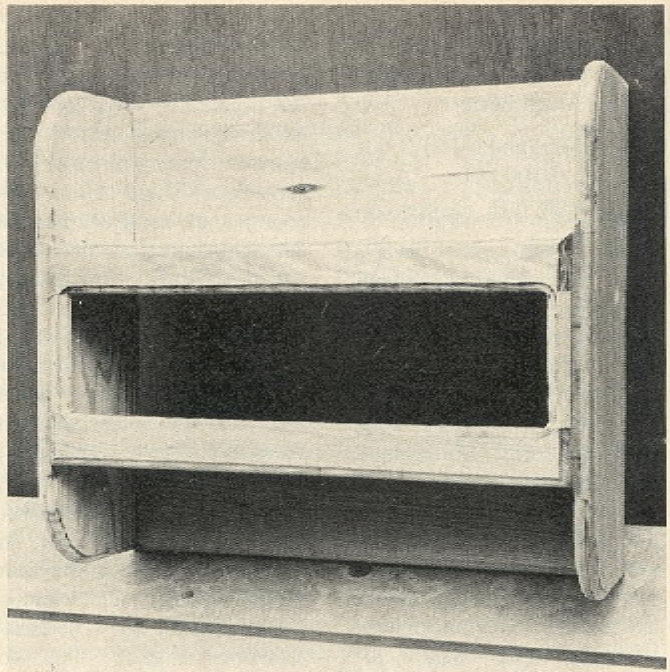
Document in this file	Article from amateur radio magazine called "73" from July, 1976, published by Wayne Green, who was also one of the founders of "Byte" magazine, later of "Kilobaud": B-7971 Nixie tube clock and circuit.
Display devices in this document	B-7971



Completed wall clock with two whatnot shelves.



Another cabinet "in the rough," ready for sanding, finishing, and the works.

Behold the Giant Nixie Clock

--using a minimum of new parts

Jack Grimes W4LLR
P.O. Box 16004
Memphis TN 38116

The May 1975 issue of *73 Magazine* contained the article "Fat Nixies For Chronometer Nuts." I'd tip my hat, if I wore one, to anyone who makes use of a surplus bargain, and the Burroughs 7971 alphanumeric tubes are a steal on the market at the present time. When used as the display for a six digit clock, they become an eye-popping conversation piece.

Having accumulated a sizable stock of the giant nixies with clocks in mind, the *73* article was a welcome sight and inspired me to get out the old soldering iron and dust off the workbench (that is if you can call four layers of assorted junk, including, but not limited to, resistors, condensers, wire, metal drill shavings, transformer laminations, etc., "dust").

My giant nixies were acquired complete with the sockets and brackets mounted on boards. Each assembly includes two nixies, two sockets, 33 transistors, about 100 resistors, 25 diodes and 18 capacitors, plus wire.

Before I began work I reached for the Radio Shack catalog to look up the price I would have to pay for the RS2008 300 volt NPN transistors specified in the article. It quickly became apparent that the $5.00 paid for the three boards (with six nixies and sockets) was only a small down payment on the finished product. Another bottleneck (at least to me) was that a quick look through the latest flyers in the shack showed no readily available source of PNP 300 volt transistors at any price. (I never did get around to writing Heathkit.)

Since I had ordered nixies to build seven of the clocks for use as gifts (for people who seem to have everything), I was somewhat reluctant to purchase the necessary 448 resistors and 175 transistors, when half or more of the little solid state devices would be costing upwards of $1.50 each. Besides that (now we get to the nitty-gritty), the pocketbook was slightly flat!

So I kept staring at those surplus boards with those 33 transistors in nice shining rows, and all those other parts. And I kept looking at the May 1975 issue of *73 Magazine* and at the spec sheets which came with the MM5314 clock chips. At one time, I reasoned, those same 33 transistors *had been used to drive the nixies.* So why not use them in the nixie clock?

It was easy to determine that the long row of transistors farthest from the brackets had been used as segment drivers (UL624). Two transistors located at one end of the board, approximately two inches behind the only 2 Watt resistors, were determined to be PNP high voltage type. Most are Motorola SA480. A few boards used Texas Instruments, designated UL480.

But I had no way of knowing how high the voltage rating was. I am sure many readers have access to books and could easily obtain the specs, but nothing I had gave the information, and inquiries among friends and on the nets failed. So I crossed and uncrossed fingers and began experimenting with the following objectives in mind:

1. Build a clock using as many parts as possible from the surplus boards.

2. Simplify the design and eliminate as many parts as possible.

I am happy to say both objectives were more successful than I dared hope. All transistors were taken from the boards, as were a large number of resistors. Even the board itself, with PC strips removed by sanding, is used as the "board chassis."

The total number of parts has been cut approximately in half, resulting in substantial savings even if the nixies are bought less boards and it is necessary to purchase transistors. As examples, my clocks use only 13 transistors rather than 25 as specified in the *73* article, only 27 resistors in circuits associated with the driver transistors compared to 64, and the power supply has a total of 3 diodes instead of 8 and 2 resistors rather than 4. At the same time, sharpness, clarity and brilliance of the numerals leave nothing to be desired.

The construction of the clock is straightforward and not difficult. It actually is built in three phases or parts, which are then brought together for the finished project: the display, the brain-board, and the cabinet.

A cabinet may be built of any material for wall mounting or for table or rack. A good grade of full one inch oak, birch, walnut or maple, etc., will make a cabinet worthy of the "works" you will build. My choice was wall clocks of wood. Once this decision was made the rest of the construction fell into place.

Since the cabinets were to be of wood, it was natural to mount the nixie socket-brackets on wood. For this purpose cut a piece of plywood or ¾" plank 16½" long x 5¾" high.

The brackets are removed from the PC boards, leaving the sockets intact, and sawed off just toward the center from the mounting holes. The two bracket ends containing the sockets may now be bolted together using the existing hole. The three boards will yield three pairs of bracket-sockets, for hours, minutes and seconds.

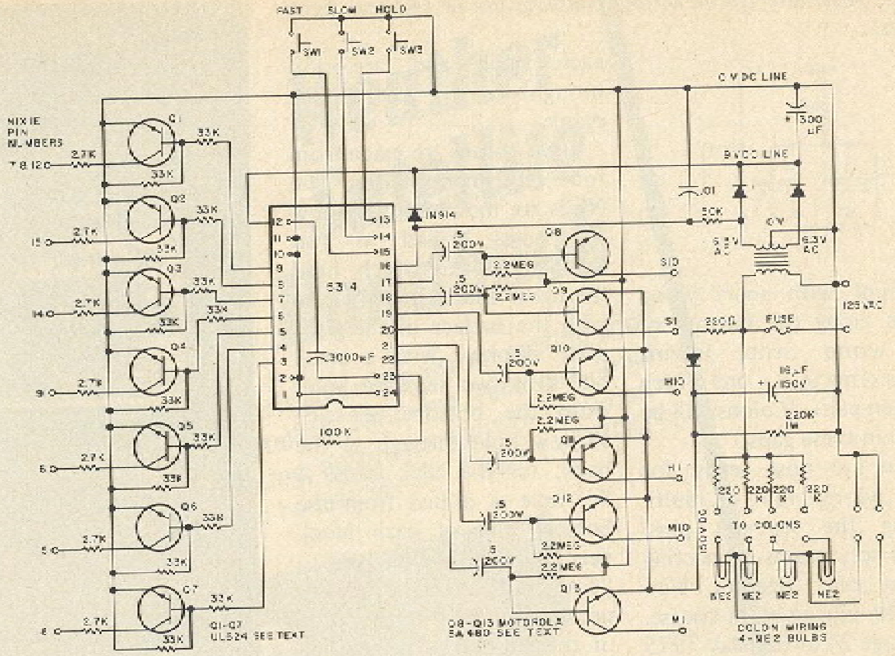
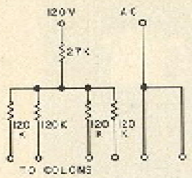


Fig. 1.

Two clocks, ready for cabinet, standing on end. A pair of colon blocks, viewed from the front and rear, stand between the clocks.

Fig. 2. Alternate colon wiring, enabling use of resistors from boards.

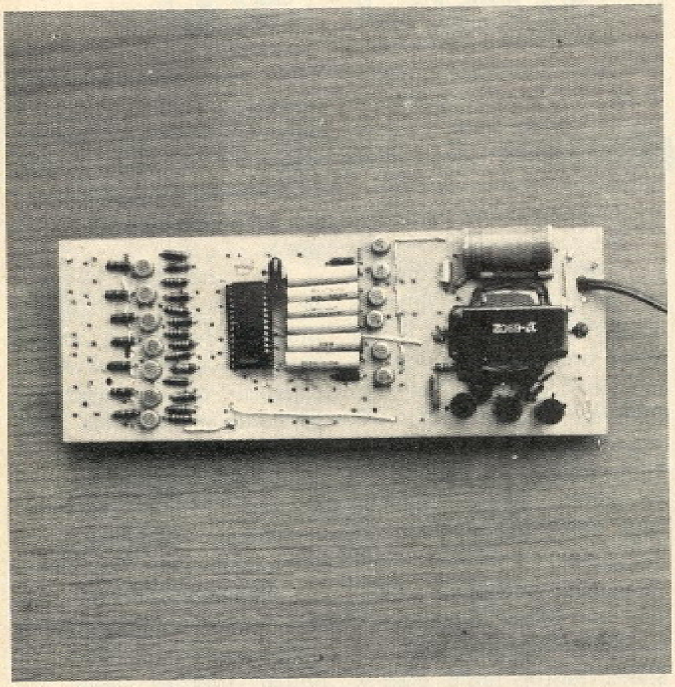


Mount with short wood screws along the bottom of the wood strip, leaving approximately one inch between pairs. (Colons will be placed in these gaps.)

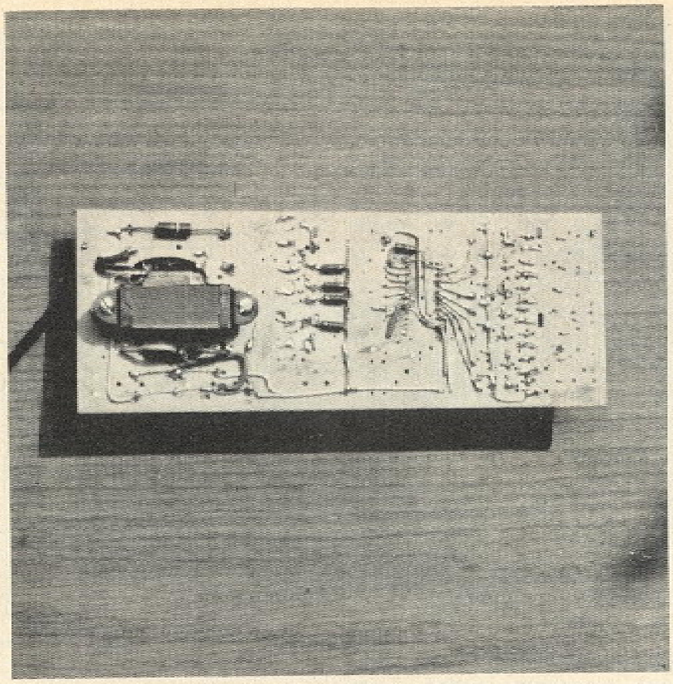
You are now ready for some wiring fun — multiplexing the segment pins. This simply means connecting all like pins together. Wire only the pins used, of course. (See page 24 of the May 1975 issue of *73 Magazine* for details.) The wires should be formed to run along the back of the sockets along the bottom edge of the wood. Use seven color coded wires; a cable is formed approximately one foot long which is passed through a ¼" hole to the back of the wooden board. Six wires, also color coded, are wired to pin 13 of each nixie and are also brought to the rear of the plank.

Two colons are made from four NE2 neon bulbs. The NE2s are mounted in shallow ¼" holes drilled in two wooden blocks which hold the lights approximately even with the surface of the giant nixie display. With a small bit, drill two separate holes from the bottom of each shallow hole through to the back, for the NE2 leads. A ¼" hole is drilled from the bottom end of each block near the back and allowed to "come out" the back midway up. In this manner the leads of the NE2s may be reached and connections made. Three wires are brought out the bottom (one common and one to each bulb). This wiring is cabled with the segment wiring and also brought to the back of the display board.

The NE2s are fed from the 120 volt ac line through four 220k resistors, which gives the proper brightness to match the display.



Top view of board. Transformer is mounted with half below the board. The three black spots below the transformer are three 100 uF filters, 25 V rating, paralleled. Segment drivers are at one end of the board. Digit enable is near the center.



Bottom view of board. Resistor above the transformer is the H. V. bleeder.

If it is desired to use parts from the board, four 120k resistors may be used, one to feed each NE2, and one 27k resistor to feed the four resistors. See alternate colon wiring.

With the display complete you are ready to tackle the "brain-board." There is no question that a printed circuit board would be the ideal way to wire the clock. But not having PC facilities and desiring to build only seven clocks, it seemed sensible to proceed with freehand layout and drilling. Actually I use old PC boards with the strips sanded off with a rotary sander.

The power supply should be wired first. A 12 volt center tap filament transformer allows use of only two diodes. However, a 6.3 volt transformer with a bridge does an equally good job. You should come out with approximately 9 volts dc for the clock chip. At this voltage the chip does not run even slightly warm and operates perfectly.

Experiments showed the giant nixies fire with a voltage much lower than the 180-200 volts. Using a lower voltage gives a safety margin for the high voltage transistors.

In the interests of cost and simplicity, a simple half wave circuit is used to rectify the line voltage for the 150 volt supply. A 16 mF capacitor with at least 150 volt rating is sufficient filtering. A 220k 1 Watt resistor serves to bleed off the voltage slowly when the clock is unplugged.

Writing this, I can almost hear the screams: "A line voltage rectifier! A hot chassis!"

Well, this clock has *no hot chassis*, because it has no (metal) chassis. Note in the diagram there are no ground symbols. Only a "0" volts dc line. This same line has one leg of the 120 V ac on it. But, kept completely under the board and enclosed in a wooden cabinet, it certainly does not present a shock hazard.

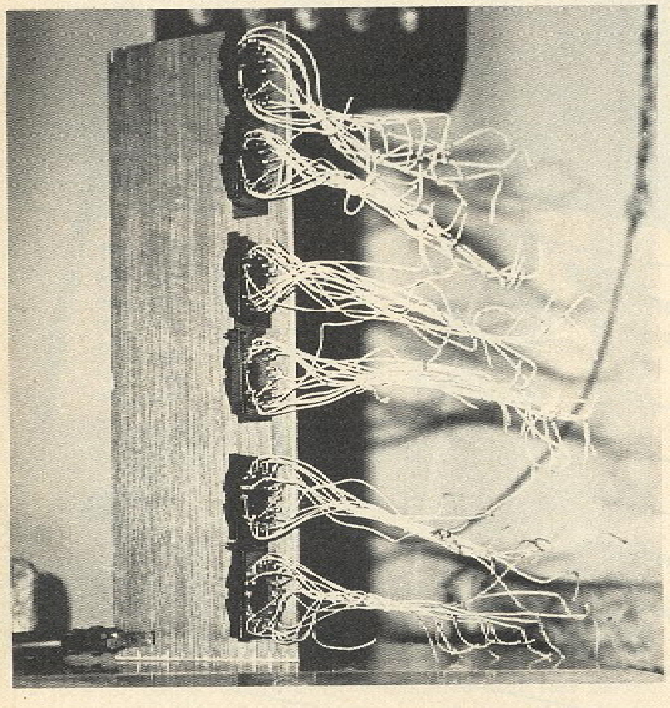
Once the power supply is complete and tested, the clock chip socket should be mounted in the approximate center of the remaining board space. Then mount the components, and wire everything

The bracket mounting, wiring, and colon mounting.

associated with pins 2, 10, 11, 12, 16, 23 and 24 of the chip. At this point, if you wish, you may install the chip and apply power.

Using a scope, if all is well, you should see pulses appearing on pins 17 through 22. If you do not have a scope, a VOM may be used and you will get a pulsing, variable reading on the 12 V scale from pins 3 through 9.

The segment drivers use the UL624 transistors from the surplus boards. I have never had one fail, even while experimenting. Only six of the 33k resistors are available from the boards. However, I have used 20k resistors from the base of the transistors to the IC chip with no noticeable change in operation of the clock. So this does not appear to be critical. Because of the much lower voltage and shorter duration of the pulses, 2.7k resistors are used for current limiting – all from the surplus boards.



Tube sockets and brackets after removal from surplus boards and mounted on wood strip. Wires are left attached and used for multiplex wiring.

The tricky part of the giant nixie clock, as mentioned in the May 1975 article, is interfacing the digit enable pulses with the high voltage transistors. It is, of course, an absolute must to keep the high voltage isolated from the low voltage chip, while at the same time passing a pulse of sufficient intensity to trigger the transistor and provide the voltage to light the proper segments of the nixies.

Fortunately such a device to do this is in existence! It was invented quite a number of years ago. This needed device is called a capacitor.

My first effort was to use the .022 condensers on the surplus boards between the chips and base of the high voltage transistors. If one turned the lights out in the shack, flickering numbers could be seen.

An 8 mF filter, + side to the base of the transistor and connected across one of the .022 capacitors, lighted a numeral brightly. But six 150 volt filters would not be exactly cheap or space saving. And the numeral had a tendency to pulse.

Any old-timer and most new hams know it takes a very large capacity to pass a low frequency, while a very small capacitor will pass a high frequency.

So, why not raise the multiple, or scanning rate, thereby increasing the frequency and shortening the duration of the pulses? Hence the 3,000 mmF condenser in the frequency determining portion of the chip circuit. With this scanning rate, .5 capacitors pass the pulse nicely. With this problem solved, building a clock became a matter of mounting parts and wiring.

One word of caution: Be sure and short the leads of each .5 condenser together before installing to be sure there is no residual charge. A capacitor holding a charge, if connected to the chip, can knock out the device.

When first firing up the clock, you may feel something is wrong as not all numerals will necessarily light. For some reason the first digit usually comes up a "3," and the other numbers will probably not make sense. But the seconds should be counting. Press the fast forward button and run the clock through a full 12 hours. If all is well, it will straighten out and the sequence will fall into place.

Building the Cabinet

For those who may wish to duplicate the wall clock, I will give the cabinet dimensions. Whatever type cabinet you decide on, the inside space will have to be large enough to accommodate the 16½" length and approximate 6" height and 5" to 6" depth.

My cabinets are built from 1" wood and overall dimensions are 24" high, 18½" wide and 8" deep. The top of the clock forms one shelf and is 7" deep. The bottom shelf is 3" deep. The wood is finished only with Formby's Tung Oil and hand rubbed – no varnish.

There is no special grooving. Only two side panels, shelves and back, cut to fit and put together with dowel pins – no nails. A piece of glass is placed in front of the nixies, as are two 2" wide pieces of trim, reducing the opening to approximately 4 inches.

The cabinets are cut out entirely with a circular and a saber saw and finished with a sander. The only special work is rounded corners and a groove for the glass, courtesy of a neighbor's router.

So-o-o, if you haven't already taken the plunge and built a really glamorous digital clock, why not? You'll have fun and the clock in the house (not the shack) is guaranteed to earn you plenty of brownie points with the XYL. She just might decide all that electronics knowledge you've been soaking up is worth something after all! ■

For those who may purchase the nixie tubes less boards, or have bad PNP high voltage transistors on a board, a source of a high voltage PNP transistor is RGS Electronics, 3650 Charles St., Suite K, Santa Clara CA 95050. The designation of this transistor is "P-8," the voltage rating 150 V. I have used this transistor completely in one clock and the results were perfect. The numerals were somewhat brighter. It was necessary to increase the capacity of the frequency control condenser when using this transistor. Cost of the "P-8": 30 cents each.

RGS also has several NPN transistors suitable for segment switching.

I have been substituting quite freely the resistors which are connected to pins 3, 4, 5, 6, 7, 8 and 9. Values as low as 15,000 Ohms work very well. The boards have a large number of these resistors on them. Also, the 33k resistors to ground (from the bases of Q1-7), are not critical. In general these resistors should be of higher value when substituting, while the resistors between base and IC should be substituted at a lower value. Of course, all substituted resistors (either string) should be of the same value, i.e., all 15,000, etc.

I have completed five additional clocks since writing the article.